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THE AGE OF THE KILLARNEY GRANITE

by

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By W. H. Collins.

INTRODUCTION.

In 1914, the writer began a study of the Pre-Cambrian formations in the district just north of Lake Huron, mainly with the intention of determining the geological succession there and of correlating it with the successions already worked out in other parts of northeastern Ontario. The principal results obtained during that season were published as Museum Bulletin No. 8 of the Geological Survey. The work was resumed last summer and a number of additional results pertaining to the geological succession in the district were obtained. A detailed report accompanied by maps, dealing with the work of both years, will be issued, but meanwhile it is proposed in this bulletin to present briefly and with less delay what appears to be the most important of this year's results: the existence of granite batholiths intrusive in the Huronian sediments.

GEOLOGICAL CHARACTER OF THE DISTRICT.

To introduce clearly the essential part of the paper it is necessary to begin with a review of the geological succession and structure. For a fuller treatment of this subject, the reader is referred to Museum Bulletin No. 8, in the series of publications to which the present article belongs. The geographical extent of the district to be dealt with is indicated in Figure 1. Within

this district the rocks are nearly all Pre-Cambrian. It is true, the Palæozoic sediments to the south overlap the Pre-Cambrian among the islands in the North channel; but these younger strata do not occur in any of the localities under present consideration. Pleistocene lake-beds and glacial till also lie directly upon the Pre-Cambrian; but, beyond concealing the bed-rock, they have no relation to the problem in hand. Attention may, therefore, be confined to the Pre-Cambrian.

A great unconformity divides the Pre-Cambrian of the district into two main parts, Huronian and pre-Huronian. The pre-Huronian, in the various portions that have been mapped, consists principally of batholithic granite-gneiss. Metaschists of igneous origin, older than the granite-gneiss and greatly metamorphosed by it, occur in much smaller amounts. Near Espanola there are also some highly metamorphosed quartzites and micaceous slates, older than the granite-gneiss. The age of these sediments relative to that of the igneous schists is not yet known. The pre-Huronian may, then, be summarily described as a highly crystalline complex, consisting mainly of batholithic granite-gneiss and subordinately of vestigial patches of igneous schists and sediments intruded by the granite-gneiss.

The Huronian sediments repose upon a deeply eroded surface of pre-Huronian crystallines. They are comparatively little metamorphosed deposits, almost flat-lying in places, closely folded and much faulted in others, but on the whole much more modern-looking than the pre-Huronian rocks. They consist dominantly of clastic materials—conglomerate, quartzite, and greywacke—with which are associated a few thin formations of siliceous limestone. The sequence of these formations is given below. An unconformity separates them into a lower, Bruce series and an upper, Cobalt series. This unconformity is a persistent one; but, because the two series have been deformed and anamorphosed to nearly the same extent, it is not conspicuous.

The Huronian sediments are intruded in many parts of the district by sills and dykes of diabase of later Pre-Cambrian, probably Keweenawan, age. Near Thessalon, they are overlain by a basic volcanic flow. The present article is written to show that they are also intruded by granite of later Pre-Cambrian age.

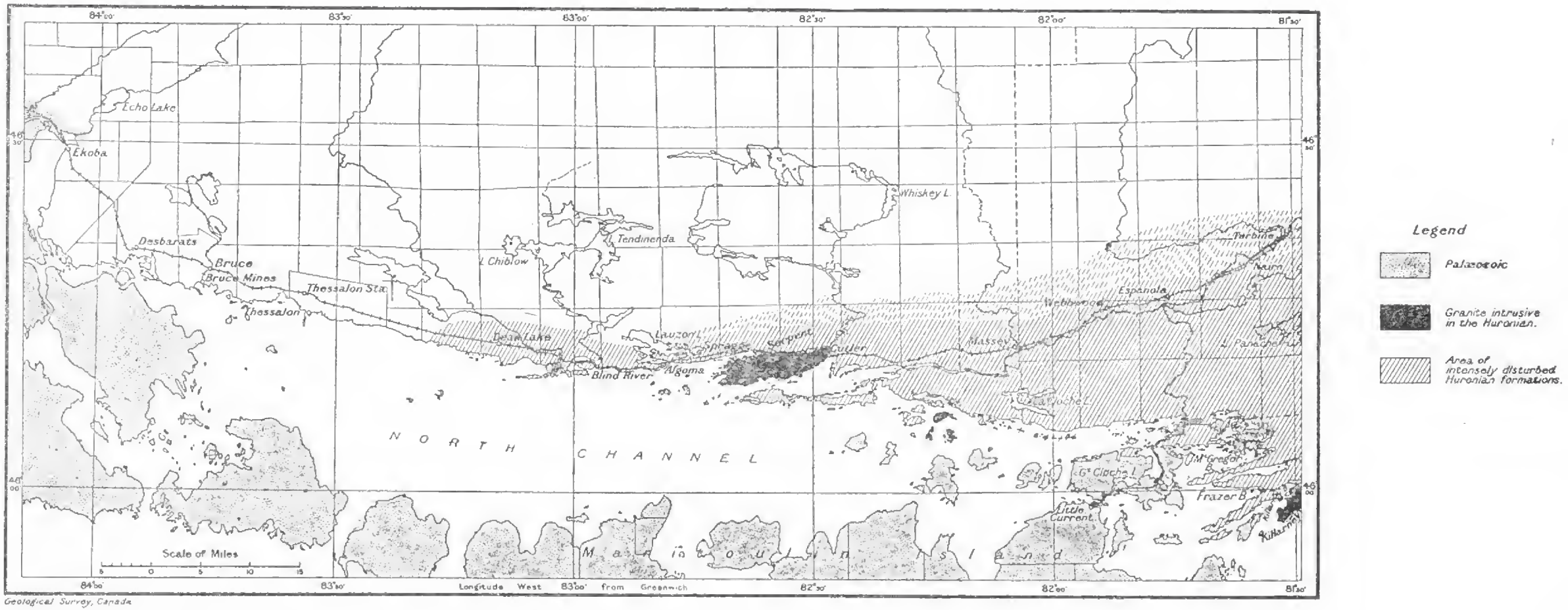

Figure 1. Map-diagram of north shore of Lake Huron, showing the extent of the highly deformed Huronian strata (shaded) and the granite masses intrusive in the Huronian (black).

The Pre-Cambrian succession north of Lake Huron follows:

Table of Formations.

			Feet
	Diabase sills and dykes, etc.		
Huronian	Cobalt series	White quartzite, yellow chert, and limestone Banded cherty quartzite	700
		Lorrain quartzite: red quartzite, jasper, conglomerate, and white quartzite	5500–6000
		Gowganda formation[1]*:* boulder conglomerate, greywacke, laminated greywacke, quartzite, and impure limestone	3000±
		Unconformity.	
	Bruce series	*Serpent quartzite:* white quartzite	1100
		Espanola limestone: siliceous magnesian limestone, less pure than the Bruce limestone	0–75
		Espanola greywacke: calcareous, thinly bedded greywacke	350
		Bruce limestone: siliceous banded limestone	150–200
		Bruce conglomerate: boulder conglomerate	20–150
		Mississagi quartzite: quartzite and arkose, conglomeratic at base and resting upon a decomposed pre-Huronian surface	1000–2000
		Unconformity.	
Pre-Huronian.		Granite-gneiss batholithic intrusives Igneous meta-schists and meta-sediments	

The argument developed hereafter is essentially simple. The granite at Killarney is shown to bear a certain relationship to sediments which are regarded as Huronian in age and from this relationship the age of the granite is determined. If doubt existed regarding the age of the sediments, equal doubt would fall upon the age ascribed to the granite. It is necessary, therefore, to establish conclusively the identity of the Huronian

[1] This name is suggested in a Geological Survey Memoir, "The Geology of Onaping Map-area," now in preparation.

rocks in question. Accordingly, attention is now directed to the great thicknesses of the Bruce and Cobalt series, to the number of formations constituting each and their order of succession; also to such characteristic formations (horizon markers) as the Bruce and Espanola formations in the Bruce series, and the extraordinary association of boulder conglomerate, laminated greywacke conglomerate, etc., in the Gowganda formation of the Cobalt series. For these are the criteria by means of which the Huronian is distinguished from other Pre-Cambrian sedimentary rocks on the north shore.

A peculiar and distinctive feature of the Bruce series, of especial recognitive value, is found in the Espanola greywacke, Espanola limestone, and Serpent quartzite. These formations are intersected by dykes of quartzite (Plate I). Dykes of this kind are rare occurrences in geological history. They have not been found in any other horizon of the Pre-Cambrian, either in this district or elsewhere in northern Ontario. They, therefore, constitute a particularly effective means of identifying the members of the Bruce series which they intersect.

DEFORMATION OF THE HURONIAN.

The successive steps which led to the age-determination of the granite at Killarney are described below in the order in which they were actually taken. This arrangement has the disadvantage of presenting the weakest evidence first; but, on the other hand, the relation of one step to the next is more apparent.

The first obvious peculiarity of the Huronian on the north shore is its unusually intense deformation. Elsewhere in northeastern Ontario and the adjoining part of Quebec (the Timiskaming region or sub-province of Museum Bulletin No. 8) the Huronian is not much disturbed. Around Lake Timiskaming and Larder lake the Cobalt series in few places dips more than 20 degrees and very few faults have been observed. There are several thousand square miles near Gowganda and Lake Timagami in which the average dip of the Cobalt series is from 20 to 30 degrees; and as far north of Lake Huron as the writer has worked in the north shore district—25 miles— the Huronian strata are notably little disturbed. They do not in many cases

dip more than 40 degrees, and dips of 15-30 degrees are commonest. In fact, over a large area between Lake Tendinenda and Mississagi river the beds are nearly horizontal. Gentle folding is the characteristic structural feature of the region.

But, as Lake Huron is approached the deformation becomes more and more pronounced. For example, the Huronian beds north of Mississagi river, near Dean Lake, dip about 15 degrees and in various directions. South of the river the dip increases rapidly to from 40 to 90 degrees and, finally, in the vicinity of the railway station, these beds are thrown against granite-gneiss by a great east-west fault. From Dean Lake eastward the Huronian strata are all steeply tilted, even overturned, and faults of various magnitudes are common.

The extent of the intensely deformed Huronian formations is shown in Figure 1. The axis of folding crosses the district in a wide, southward-curved arc. About Echo lake and Bruce Mines, in the west, the strike averages south 30 degrees east, at Blind River it is due east, and, in the east, near Espanola and Lake Penage, it is north 75 degrees east. The southward extent of this area of disturbance is concealed by the overlapping Palæozoic formations. It probably continues eastward to near Lake Wanapitei.

This area of deformation is an exceptional structural feature in northeastern Ontario and, naturally, one in which exceptional causative influences are to be expected. For this reason particular attention was given to it, as shown below, between Algoma and Cutler.

GEOLOGICAL RELATIONSHIPS NEAR CUTLER.

Classification of the disturbed Huronian formations offers particular difficulty. The very fact that the rocks are so much more deformed than those in other parts of the district requires that the evidence for their comparison be unusually strong. At the same time it makes such evidence harder to obtain because the deformed rocks have been more metamorphosed than the less disturbed ones and their original lithological resemblances have been correspondingly obscured. It is necessary to depend more upon the actual tracing of formations from

point to point and upon the comparison of formational sequences; but both of these methods are likewise impaired by the numerous faults which have locally destroyed the former geological continuity of the area.

These difficulties were first seriously felt during 1914 in the vicinity of Blind River and Algoma. The sediments there stand nearly on edge and some diffidence was felt in correlating them with the nearly flat-lying Huronian formations not many miles to the north, especially as a great east-west fault was known to intervene. Before the close of 1914, however, all the rocks were satisfactorily determined except those which occupy the peninsula and southern bay of Lake Lauzon, and extend eastward into territory unexamined at that time.

These rocks are bounded on the north by a well-defined east-west fault, beyond which Mississagi quartzite rests upon pre-Huronian granite-gneiss. The fault effectively prevents correlation in this direction. The connexion southward is hidden by Lake Lauzon and Lake Huron. The connexion westward is obscured by soil covering; but in that direction lies a large area of Cobalt series, perhaps in continuity with the rocks in question. These rocks comprise a boulder conglomerate with fine-grained greywacke cement, a finely banded greywacke, and interbedded greywacke and quartzite, all in series. They closely resemble certain members of the Gowganda formation in the Cobalt series; in fact, no other suite of Pre-Cambrian formations just like them has yet been found along the north shore. This evidence, however, was not regarded as adequate for their sure identification. At the end of the 1914 field season it could only be said that, lithologically and in their order of succession, the rocks at the southeast end of Lauzon lake resembled part of the Cobalt series, but really conclusive evidence, such as a more extensive sequence of formations, or relationships to some other known series, was still needed.

In 1915, it was decided to seek this confirmatory evidence, by tracing the debatable conglomerate, greywacke, and quartzite eastward. In pursuance of this plan they were followed in this direction for 12 miles, as far as Cutler. The fault on the north was found to persist the whole way, with Mississagi quartzite

and gneiss on the other side of it. Between the fault and Lake Huron the sediments are all conglomerate, greywacke, and quartzite, plainly continuations of those seen in Algoma in 1914. So far, therefore, as the more certain identification of these sediments is concerned nothing was accomplished. They are still regarded as probably, but only probably, a part of the Cobalt series.

But in the attempt to establish more certainly their identity another quite different relationship was revealed. The farther eastward the sediments were traced the more highly metamorphosed did they become. The quartzite became hard and glassy, the conglomerate cement grew crystalline and the pebbles flattened, and the greywacke gave place gradually to a micaceous schist. Between Serpent and Cutler these highly altered sediments were found to be invaded by a mass of granite which occupies the peninsula south of the Canadian Pacific railway. It was then evident that the metamorphism of the sediments was due to the intrusion of this granite.

If the sediments were Huronian, it was necessary to regard the granite at Cutler also as Huronian or post-Huronian. This conclusion was supported by one other circumstance. Just north of Cutler the granite mass approaches to within an eighth of a mile of the Mississagi quartzite, the identity of which is not in doubt; and at this point the quartzite is unusually glassy, presumably as a result of contact metamorphism. If this glassiness in the Mississagi quartzite is really due to contact metamorphism, it follows that the granite must be at least younger than the Bruce series.

At the end of this field investigation the evidence regarding the age of the granite at Cutler remained indecisive. So far as the present paper is concerned the net results were a rather strong probability that the Cutler granite mass was intrusive in the Huronian and a desire to find elsewhere really conclusive proof of this relationship. Up to the time of this investigation no granite intrusive in the Huronian had been found in northeastern Ontario although the Huronian in many parts of this region had been carefully studied. The occurrence of such a formation on the north shore had, therefore, to be especially

well proven. With the immediate object of searching for such proof a visit was paid to the vicinity of Killarney. Killarney was selected for this purpose because the writings of earlier observers in that locality (Murray 1849, Bell 1876, and Barlow 1893) referred to a granite intrusive in sediments, the descriptions of which suggested the Bruce series although they had not been differentiated from the pre-Huronian sediments.

GEOLOGICAL RELATIONSHIPS NEAR KILLARNEY.

The time spent near Killarney was devoted altogether to reconnoitring the neighbourhood with the object of locating Huronian sediments which could be certainly recognized as such, and then determining the relation of these to the Killarney granite. No attempt was made to map all the rocks in the locality.

A nearly complete sequence of the Bruce series was soon found in McGregor bay, on the large island immediately south of McGregor island (see Figure 1). The strata in this bay, as elsewhere in the neighbourhood, are nearly on edge and strike about north 75 degrees east. The southern part of McGregor island is underlain by a thick quartzite formation. Towards the south the quartzite is followed conformably by a dark boulder conglomerate about 150 feet thick. The conglomerate gives place abruptly but conformably to nearly 100 feet of siliceous limestone, which, in its turn, grades into dark, greenish greywacke, the weathered surface of which is peculiarly corrugated. The greywacke is several hundred feet thick and in its southerly portion becomes by degrees interbedded with quartzite, by which it is finally wholly replaced. This quartzite is also of important thickness. In the order given these formations agree closely with the upward succession of the Bruce series, that is, the quartzite on McGregor island corresponds to the Mississagi quartzite, the boulder conglomerate to the Bruce conglomerate, the limestone to the Bruce limestone, the greywacke to the Espanola greywacke and limestone, and the quartzite on the south to the Serpent quartzite. That the top of the sequence actually lies to the south in this place was confirmed by examining ripple-marks in the upper quartzite.

The identity of these formations was further confirmed by finding the greywacke intersected at one point by a 4-inch quartzite dyke similar to that shown in the accompanying illustration. It has already been stated that dykes of this unusual nature have been found only in the middle members of the Bruce series and are regarded as an especially effective identification mark. On these grounds the formations in McGregor bay are regarded as Bruce series.

In lithological appearance some of these rocks differ considerably from typical Bruce Series rocks found in less disturbed areas north of Lake Huron, but this is the result of metamorphism. The limestone has been partly converted into a lime-silicate rock and the greywacke is unusually dark and crystalline. In spite of these alterations, however, the original lithological characteristics persist strongly.

A similar though much less complete succession was found at the upper end of Killarney bay. These rocks are best exposed on some rocky islets in the constricted tip of the bay. The dark corrugated Espanola greywacke is the chief formation exposed, though there is also some limestone interbedded with greywacke, and some of the conglomerate. All are intensely metamorphosed. Had it been necessary to compare them directly with the little metamorphosed members of the Bruce series in the northern part of the north shore district, e.g. at Bruce Mines or Whiskey lake, some uncertainty might have existed; but their similarity to the metamorphosed varieties in McGregor bay is unequivocal.

Their relations to the Killarney granite, which extends along the south shore of Killarney bay, are equally positive. In the grassy southward-pointing tip of the bay the Espanola greywacke is in immediate contact with the granite, the latter being intrusive. In the same vicinity the granite alongshore contains numerous highly crystalline xenoliths of material which can be recognized as Espanola greywacke. In the writer's opinion the sediments described certainly belong to the Bruce series. The granite intrusive in them is consequently younger than the Bruce series.

Quartzite "dyke" intersecting limestone and greywacke of the Bruce series on an islet one mile south of Fort Lacloche, Lake Huron.

Similar relations between the Bruce series and a granite like that at Killarney were afterwards observed among the islands in the North channel. The small islands near shore, from south of Lake Lacloche to near Aird island, are part of an east-west belt of the Bruce series. All the formations in the series are represented. The quartzite dyke shown in Plate I was observed on an islet directly south of the outlet of Lacloche lake. The relationship of the series to the neighbouring granite can be seen on Fox island, along the north shore of which the granite intrudes quartzite, sending irregular apophyses into it and altering it locally to a spotted quartzite.

THE KILLARNEY GRANITE.

Comparatively little is yet known about the extent, mode of intrusion, and petrological nature of the Killarney granite. Barlow[1] traced the contact of granite and gneiss with the Pre-Cambrian sediments from Killarney eastward to near Wanapitei, but he did not distinguish the granite from the gneiss, which is probably not of the same age. Bell[2] mapped the Killarney granite among the islands of Lake Huron. To this work is added the writer's observations in 1915.

At Killarney, the granite is a rather coarse-grained, light red rock, apparently without gneissic foliation. Its contact edges are not fine-grained. Salmon-red feldspar is the chief constituent. Quartz is so subordinate in quantity that the rock approaches a syenite in composition. The dark mineral is biotite. The granite seen on Fox and adjoining islands is of the same description.

The granite at Cutler is different in appearance from that at Killarney and Fox island and may be an intrusive distinct from it. It is a medium-grained grey granite composed of white feldspar, quartz, and both dark and light varieties of mica. Like the Killarney granite it shows no gneissic structure. It is intersected abundantly by dykes of pegmatite consisting of quartz, feldspar, and muscovite, the latter occasionally in

[1] Relations of the Laurentian and Huronian rocks north of Lake Huron: Bull. G.S.A., Vol. IV, pp. 313-332.

[2] Rept. of Progress, G.S.C., 1876-77.

plates of marketable size. This granite mass, it may be repeated, has not been proven conclusively to be younger than the Huronian.

The approximate distribution of these granites along the north shore is indicated in Figure 1. They show no tendency to become fine-grained at their contacts, and this together with the intensity with which they have contact-metamorphosed the adjacent sediments implies that they are masses of important size. The intruded sediments are steeply tilted, and are fractured and invaded by apophyses in much the same manner as are the rocks bordering the pre-Huronian batholiths.

CONCLUSIONS.

The Huronian formations along the coast of Lake Huron have been folded and faulted to a degree such as elsewhere in the Pre-Cambrian is usually ascribed to orotectic movements. Huronian formations deformed to this extent have not been found elsewhere in northeastern Ontario.

Within this disturbed area there are granite masses of batholithic nature which intrude the Bruce series, and probably also the Cobalt series. No such granitic intrusives have hitherto been found in northeastern Ontario.

The disturbance and granite invasion were both complete long before Ordovician time, for early Ordovician sediments lie horizontally upon a deeply eroded surface of the disturbed Pre-Cambrian.

LIST OF MUSEUM BULLETINS.

The Museum Bulletins, published by the Geological Survey, are numbered consecutively and are given a series number in addition, thus: Geological Series No. 1, 2, 3, etc.; Biological Series No. 1, 2, 3, etc.; Anthropological Series No. 1, 2, 3, etc.

In the case of Bulletins 1 and 2, which contain articles on various subjects, each article has been assigned a separate series number.

The first Bulletin was entitled *Victoria Memorial Museum Bulletin;* subsequent issues have been called *Museum Bulletins.*

MUS. BULL. 1. *Geol. Ser. 1.* The Trenton crinoid, Ottawacrinus, W. R. Billings—by F. A. Bather.

Geol. Ser. 2. Note on Merocrinus, Walcott—by F. A. Bather.

Geol. Ser. 3. The occurrence of Helodont teeth at Roche Miette and vicinity, Alberta—by L. M. Lambe.

Geol. Ser. 4. Notes on Cyclocystoides—by P. E. Raymond.

Geol. Ser. 5. Notes on some new and old Trilobites in the Victoria Memorial Museum—by P. E. Raymond.

Geol. Ser. 6. Description of some new Asaphidae—by P. E. Raymond.

Geol. Ser. 7. Two new species of Tetradium—by P. E. Raymond.

Geol. Ser. 8. Revision of the species which have been referred to the genus Bathyurus (preliminary report)—by P. E. Raymond.

Geol. Ser. 9. A new Brachiopod from the base of the Utica—by A. E. Wilson.

Geol. Ser. 10. A new genus of dicotyledonous plant from the Tertiary of Kettle river, British Columbia—by W. J. Wilson.

Geol. Ser. 11. A new species of Lepidostrobus—by W. J. Wilson.

Geol. Ser. 12. Prehnite from Adams sound, Admiralty inlet, Baffin island, Franklin—by R. A. A. Johnston.

Biol. Ser. 1. The marine algæ of Vancouver island—by F. S. Collins.

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Biol. Ser. 3. Hydroids from Vancouver island and Nova Scotia—by C. McLean Fraser.

Anthrop. Ser. 1. The archæology of Blandford township, Oxford county, Ontario—by W. J. Wintemberg.

MUS. BULL. 2. *Geol. Ser. 13.* The origin of granite (micropegmatite) in the Purcell sills—by S. J. Schofield.

Geol. Ser. 14. Columnar structure in limestone—by E. M. Kindle.

Geol. Ser. 15. Supposed evidences of subsidence of the coast of New Brunswick within modern time—by J. W. Goldthwait.

Geol. Ser. 16. The Pre-Cambrian (Beltian) of southeastern British Columbia and their correlation—by S. J. Schofield.

Geol. Ser. 17. Early Cambrian stratigraphy in the North American Cordillera, with discussion of the Albertella and related faunas—by Lancaster D. Burling.

Geol. Ser. 18. A preliminary study of the variations of the plications of Parastrophia hemiplicata, Hall—by Alice E. Wilson.